APPENDIX A

APPENDIX A

Table 1

MAXIMUM PERMISSIBLE DOSES[d] (DOSE EQUIVALENTS)

	Average weekly dose[a]	Maximum 13-week dose	Maximum yearly dose	Maximum accumulated dose[b]
	rem [c]	*rem* [c]	*rem* [c]	*rem* [c]
Controlled areas—Occupational Exposure				
Whole body, gonads, blood-forming organs, and lens of eye	0.1	3	----------	5(N-18)
Skin of whole body	----------	10 [e]	30 [e]	----------
Hands and forearms, head, neck, feet, and ankles	----------	25	75	----------
Environs—Nonoccupational Exposure				
Any part of body	.01	----------	0.5	----------

Notes:

N = Age in years and is greater than 18.

[a]For design purposes only.

[b]When the previous occupational exposure history of an individual is not definitely known, it shall be assumed that he has already received the full dose permitted by the formula 5(N-18). Persons who were exposed in accordance with the former maximum permissible weekly dose of 0.3 rem and who have accumulated a dose higher than that permitted by the formula shall be restricted to a maximum yearly dose of 5 rem.

[c]The dose in rems may be assumed to be equal to the exposure dose in roentgens.

[d]Exposure of patients for medical and dental purposes is not included in the maximum permissible dose.

[e]See Am. J. Roen. 84, 152(1960).

[f]Where an employee's accumulative exposure is partly due to radiation from isotopes and partly to radiation from x-ray units, the limits established in Table I, Appendix A would apply to the sum of the radiation exposures.

[g]Occupationally exposed personnel should receive no more than 10 percent of the limits in the above table when pregnant.

Table 2

AVERAGE OUTPUT OF DIAGNOSTIC EQUIPMENT

Target distance		Tube potential						
		50 kvp	60 kvp	70 kvp	80 kvp	90 kvp	100 kvp	125 kvp
		r/100 ma-sec						
in.	*cm*							
12	30	1.8	2.8	4.2	5.8	8.0	9.8	15.2
18	46	0.8	1.3	1.8	2.5	3.4	4.2	6.7
24	61	.4	0.7	1.1	1.4	1.9	2.3	3.8
36	91	.2	.3	0.5	0.6	0.9	1.1	1.7
54	137	.1	.1	.2	.3	.4	0.5	0.7
72	183	.1	.1	.1	.2	.2	.3	.4

Measured in air with total filtration equivalent to 2.5 mm Al.

Table 3

DENTAL UNIT OUTPUT

Kvp	FSD	Total filter	r/ma-min
	in.	*mm Al*	
50	4	1.5	12
70	8	1.5	8.3
70	16	1.5	2.1
90	8	2.5	8.4
90	16	2.5	2.1

Table 4

DISTANCE PROTECTION (IN FEET) AGAINST USEFUL BEAM IN CONTROLLED AREAS

[For design purposes only, the maximum permissible exposure is taken to be 100 mr/wk.]

Kilovoltage	50	70	100	250	1,000	2,000
X-ray output (K_0) (r/ma-min at 1 m)	0.05	0.1	0.4	2	20	280
W UT[a]	Distance in feet					
2	3	5	9	20	60	200
4	5	7	13	28	76	270
7	6	9	17	37	105	335
8	7	10	19	40	115	350
12	8	12	23	47	130	415
15	9	13	25	52	145	450
30	12	17	35	69	190	550
50	15	22	44	85	230	650
60	16	24	47	92	240	700
125	22	33	62	120	320	850
150	24	35	66	130	335	880
200	27	38	75	140	375	950
250	30	42	80	155	400	1,000
500	40	55	100	200	500	1,150
600	42	58	107	210	530	1,200
800	47	65	120	235	570	1,275
1,000	50	70	130	250	600	1,350
2,000	62	85	165	310	720	1,500
2,500	69	90	175	330	760	1,575
4,000	75	102	200	370	850	1,700
10,000	95	130	250	480	1,030	1,950
40,000	125	180	350	640	1,300	2,350

[a] *W* = workload in milliampere-minutes per week.
U = use factor.
T = occupancy factor.

Table 5

DISTANCE PROTECTION (IN FEET) AGAINST USEFUL BEAM IN AREAS OUTSIDE OF CONTROLLED AREAS (ENVIRONS)

[For design purposes only, the maximum permissible exposure is taken to be 10 mr/wk.]

Kilovoltage	50	70	100	250	1,000	2,000
X-ray output (K_0) (r/ma-min at 1 m)	0.05	0.1	0.4	2	20	280
WUT[a]	Distance in feet					
2	11	15	30	50	160	480
4	15	20	38	77	220	590
7	18	25	50	95	255	690
8	20	27	52	100	270	720
12	23	31	60	116	310	800
15	25	35	65	127	340	850
30	32	45	85	165	430	1,000
50	38	55	102	195	510	1,150
60	40	59	110	210	530	1,200
125	53	78	140	265	670	1,400
150	56	84	150	280	700	1,450
200	62	95	165	310	750	1,550
250	65	102	175	330	800	1,600
500	85	130	220	400	940	1,800
600	90	145	232	420	990	1,850
800	100	150	250	460	1,050	1,920
1,000	110	160	270	490	1,100	2,000
2,000	135	200	330	570	1,250	2,150
2,500	145	210	345	600	1,300	2,200
4,000	165	240	375	650	1,400	2,300
10,000	210	300	460	750	1,550	2,550
40,000	280	390	580	900	1,750	2,850

[a] *W* = workload in milliampere-minutes per week.
U = use factor.
T = occupancy factor.

Table 6

SHIELDING FOR RADIOGRAPHIC FILMS

(Indicated thicknesses required to reduce radiation to 1 mr for a weekly workload of 1,000 ma-min at 100 kvp, 400 ma-min at 125 kvp, or 200 ma-min at 150 kvp)

Storage time	Type of barrier	Distance from tube to stored films											
		7 ft (2.13 m)			10 ft (3.05 m)			14 ft (4.26 m)			20 ft (6.10 m)		
		Lead		Concrete[a]	Lead		Concrete[a]	Lead		Concrete[a]	Lead		Concrete[a]
		mm	*in.*	*in.*	*mm*	*in.*	*in.*	*mm*	*in.*	*in.*	*mm*	*in.*	*in.*
1 hour	Primary	2.0	3/32	6.1	1.8	1/16	5.4	1.5	1/16	4.8	1.3	1/16	4.1
1 day	Primary	2.7	3/32	8.0	2.5	3/32	7.4	2.2	3/32	6.7	2.0	3/32	6.0
1 week	Primary	3.4	1/8	9.6	3.1	1/8	8.9	2.8	1/8	8.2	2.6	3/32	7.6
1 month	Primary	3.8	5/32	10.9	3.6	5/32	10.2	3.3	1/8	9.6	3.1	1/8	8.9
1 hour	Secondary	0.3	--------	1.1	0.2	--------	0.6	--------	--------	--------	--------	--------	--------
1 day	Secondary	.9	1/32	2.9	.7	1/32	2.3	0.5	--------	1.7	0.3	--------	1.1
1 week	Secondary	1.4	1/16	4.4	1.2	1/16	3.7	1.0	1/32	3.1	.7	1/32	2.4
1 month	Secondary	1.9	1/16	5.7	1.6	1/16	5.0	1.4	1/16	4.4	1.2	1/16	3.7

[a]Note.—Concrete thicknesses approximate.

Table 7

OCCUPANCY FACTORS

For use as a guide in planning shielding when complete occupancy data are not available. The maximum permissible dose levels stated in Addendum to H 59, April 15, 1958, summarized in table 1, are computed on the basis of the integration of doses received over a period of a year. Therefore, the degree of occupancy of an area should be considered in terms of the time which may be spent in that area by any one person over a period of a year.

Full occupancy ($T=1$)
Control space, offices, nurses stations, corridors, and waiting space large enough to hold desks, darkrooms, workrooms, shops, restrooms, and lounge rooms routinely used by occupationally exposed personnel, living quarters, children's play areas, occupied space in adjoining buildings.
Partial occupancy ($T=1/4$)
Corridors too narrow for desks, utility rooms, rest, and lounge rooms not used routinely by occupationally exposed personnel, wards and patient's rooms, elevators using operators, unattended parking lots, patient's dressing rooms.
Occasional occupancy ($T=1/16$)
Closets too small for future occupancy, toilets not used routinely by occupationally exposed personnel, stairways, automatic elevators, sidewalks, streets.

Table 8

USE FACTORS FOR PRIMARY BARRIERS

[for use as guides in planning shielding when complete data are not available.]

	Radiographic	Dental	Therapeutic[a]
Floor	1	1/16	1
Walls	1/4	1/4	1/4
Ceiling	1/16	1/16	1/16

[a]Use factors for the walls and ceiling may be much greater, or the use factor for the floor smaller, when rotation therapy is used.

Table 9

HALF-VALUE LAYER

(Approximate half-value layers obtained at high filtration for the indicated tube potentials under broad-beam conditions)

Attenuating material	hvl for various tube potentials												
	50 kvp	70 kvp	100 kvp	125 kvp	150 kvp	200 kvp	250 kvp	300 kvp	400 kvcp	500 kvcp	1,000 kvcp	2,000 kvcp	3,000 kvcp
Lead (mm)	0.05	0.18	0.24	0.27	0.3	0.5	0.8	1.3	2.2	3.6	8.0	12.0	15.0
Concrete (in.)	.2	.5	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.8	2.45	2.95
Concrete (cm)	.51	1.27	1.8	2.0	2.3	2.5	2.8	3.0	3.3	3.6	4.6	6.2	7.5

Table 10

COMMERCIAL LEAD SHEETS

Thickness		Weight
mm	*in*	*lb/sq ft*
0.79	1/32	2
1.00	5/128	2-1/2
1.19	3/64	3
1.58	1/16	4
1.98	5/64	5
2.38	3/32	6
3.17	1/8	8
4.76	3/16	12
6.35	1/4	16
8.50	1/3	20
10.1	2/5	24
12.7	1/2	30
16.9	2/3	40
25.4	1	60

Table 11

DENSITIES OF COMMERCIAL BUILDING MATERIALS

Material	Density range	Density of average sample
	g/cc	*g/cc*
Brick	1.6 to 2.5	1.9
Granite	2.60 to 2.70	2.63
Limestone	1.87 to 2.69	2.30
Marble	2.47 to 2.86	2.70
Sand plaster		1.54
Sandstone	1.90 to 2.69	2.20
Siliceous concrete	2.25 to 2.40	2.35
Tile	1.6 to 2.5	1.9

Note.—Concrete and cinder blocks vary too much to be listed.

Table 12

MINIMUM LEAD EQUIVALENT, IN MILLIMETERS, OF THE WALL SECTIONS

Wall Section	Kilovolts (Peak)			
	70	80	90	100
Eight-inch cinder block with 7/8-inch thick Portland cement mortar and 5/16-inch thick 4 x 4-inch ceramic wall tile on both sides	1.02	1.16	1.25	1.22
Eight-inch cinder block with Portland cement mortar and 5/16-inch thick 4 x 4-inch ceramic wall tiles on one side and 3/16-inch thick 1 x 1-inch ceramic mosaic tile on the other	1.13	1.23	1.35	1.28
Eight-inch cinder block with 9/16-inch barium mortar on both sides, 5/16-inch thick 4 x 4-inch ceramic wall tile on one side, and 3/16-inch thick 1 x 1-inch ceramic mosaic tile on the other	1.83	2.48	2.84	2.69
Three-inch Gypsum Pyrobar with 7/8-inch thick Portland cement mortar and 5/16-inch thick 4 x 4-inch ceramic wall tile on both sides	0.93	1.00	1.01	0.97
Three-inch Gypsum Pyrobar with 7/8-inch thick Portland cement mortar on both sides	0.76	0.78	0.83	0.82
Two-inches of gypsum plaster on metal lath	0.37	0.37	0.40	0.40
Two 3/4-inch layers of gypsum plaster on metal lath with a 3 1/4-inch space between layers	0.36	0.37	0.39	0.40
Prefabricated steel wall consisting of two layers of 20-gauge (0.0375 inch) sheet steel and 3-inches of Fiberglas insulation	0.33	0.32	0.32	0.31

Table 13

SECONDARY BARRIER REQUIREMENTS FOR LEAKAGE RADIATION FROM DIAGNOSTIC-TYPE PROTECTIVE TUBE HOUSINGS FOR CONTROLLED AREAS

(Add 3.3 hvl for Environs)

Distance from target in feet	Operating time in hours per week					
	2	5	10	15	25	40
	Number of half-value layers					
3	1.3	2.6	3.6	4.2	4.9	5.6
4	0.5	1.8	2.8	3.4	4.1	4.8
5	----------	1.2	2.1	2.7	3.5	4.1
6	----------	0.6	1.6	2.2	2.9	3.6
7	----------	.2	1.2	1.8	2.5	3.2
8	----------	----------	0.8	1.3	2.1	2.8
9	----------	----------	.4	1.0	1.7	2.4
10	----------	----------	.2	0.7	1.4	2.1
12	----------	----------	----------	.3	0.9	1.6

Table 14

SECONDARY BARRIER REQUIREMENTS FOR LEAKAGE RADIATION FROM THERAPEUTIC-TYPE PROTECTIVE TUBE HOUSINGS FOR CONTROLLED AREAS

(Add 3.3 hvl for Environs)

Distance from target in feet	Operating time in hours per week					
	2	5	10	15	25	40
	Number of half-value layers					
3	4.6	5.9	6.9	7.5	8.2	8.9
4	3.8	5.1	6.1	6.7	7.4	8.1
5	3.2	4.5	5.5	6.1	6.8	7.4
6	2.6	3.9	4.9	5.5	6.3	7.0
7	2.2	3.5	4.5	5.1	5.8	6.5
8	1.8	3.1	4.1	4.7	5.4	6.1
9	1.5	2.8	3.7	4.3	5.1	5.8
10	1.2	2.5	3.5	4.0	4.8	5.5
12	0.6	1.9	2.9	3.5	4.3	4.9
15	.0	1.3	2.3	2.9	3.6	4.3
20	----------	0.5	1.5	2.0	2.8	3.5
30	----------	----------	0.3	0.9	1.6	2.3

Table 15

EFFECT OF TUBE POTENTIAL ON PATIENT'S DOSE

(Filter—2 mm Al)

Thickness of part	Ratio of entrance to exit dose				
	50 kvp	75 kvp	100 kvp	125 kvp	150 kvp
10 cm	85	30	18	11	8
20 cm	1,250	400	140	60	30

Based on chart by F. Wachsman, Fortschr Rö.-Str., LXXV, 728 (1951); Brit. J. Radiol., Supp. No. 6, 87 (1955).

Table 16

EFFECT OF VOLTAGE, DISTANCE AND FILTRATION ON AIR EXPOSURE RATE AT PANEL OF FLUOROSCOPES

Potential	Current	Target-to-skin distance	Equivalent aluminum filtration[a]			
			1 mm	2 mm	3 mm	4 mm
kvp	*ma*	*in.*	*r/min*	*r/min*	*r/min*	*r/min*
80	3	12	27.5	14.6	9.0	6.1
		15	17.6	9.3	5.8	3.9
		18	12.4	6.5	4.0	2.7
100	3	12	38.5	22.8	15.5	11.2
		15	24.6	14.6	9.9	7.2
		18	17.1	10.1	6.9	5.0
120	3	12	55.0	33.1	22.7	16.8
		15	35.2	21.2	14.5	10.7
		18	24.5	14.7	10.1	7.5

[a]Filtration includes that of the table top and the tube with its inherent and added filter.

Table 17

THICKNESS OF LEAD AND BRASS REQUIRED TO REDUCE USEFUL BEAM TO 5 PERCENT

Tube potential	hvl	lead	Brass
kvp	*mm*	*mm*	*mm*
60	1.2 Al	0.10	0.3
100	1.0 Al	.15	.8
100	2.0 Al	.25	1.0
100	3.0 Al	.35	1.2
140	0.5 Cu	.7	4.0
200	1.0 Cu	1.0	9.0
250	3.0 Cu	1.7	18.0
300	4.0 Cu	2.7	22.3

Composition of brass used, 65 percent copper, 35 percent zinc (yellow brass).

APPENDIX B

APPENDIX B

Table 1

SECONDARY BARRIER REQUIREMENTS FOR BUSY FLUOROSCOPIC INSTALLATIONS

(W = 2,000 ma-min/week at 100 kvp, 800 ma-min/week at 125 kvp, or 400 ma-min/week at 150 kvp.)

For type of area	*UT*	Distance from tube to occupied area																			
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
Controlled	1	0.7	1/32	1.6	2.2	27	0.6	1/32	1.4	2.0	25	0.4	------	0.9	1.4	17	0.2	------	0.5	0.8	10
Environs	1	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	3.8	47	1.0	1/32	2.3	3.2	39	0.8	1/32	1.9	2.8	34
	1/4	1.0	1/32	2.3	3.2	39	0.8	1/32	1.9	2.8	34	0.7	1/32	1.6	2.2	27	.5	------	1.2	1.7	21
	1/16	0.7	1/32	1.6	2.2	27	.5	------	1.2	1.7	21	.3	------	0.7	1.1	13	.1	------	0.2	0.4	5

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

Table 2

SHIELDING REQUIREMENTS FOR BUSY RADIOGRAPHIC INSTALLATIONS

(W = 1,000 ma-min/week at 100 kvp, 400 ma-min/week at 125 kvp, or 200 ma-min/week at 150 kvp.)

Type of barrier	UT	Distance from tube to occupied area																			
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
For controlled areas:																					
Primary	1	1.9	1/16	4.4	6.1	75	1.7	1/16	4.0	5.3	65	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	3.8	47
	1/4	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	3.8	47	1.0	1/32	2.3	3.2	39	0.8	1/32	1.9	2.8	34
	1/16	1.0	1/32	2.3	3.2	39	0.8	1/32	1.9	2.8	34	0.7	1/32	1.6	2.2	27	.5	------	1.2	1.7	21
Secondary	1	0.5	------	1.2	1.7	21	.4	------	0.9	1.4	17	.2	------	0.5	0.8	10	0	------	------	0	------
For environs:																					
Primary	1	2.7	3/32	6.3	8.1	99	2.4	3/32	6.6	7.2	88	2.2	3/32	5.1	6.6	81	2.0	3/32	4.7	6.2	76
	1/4	2.2	3/32	5.1	6.6	75	1.9	1/16	4.4	6.1	75	1.7	1/16	4.0	5.3	65	1.5	1/16	3.5	5.0	61
	1/16	1.7	1/16	4.0	5.3	65	1.5	1/16	3.5	5.0	61	1.3	1/16	3.0	4.0	53	1.1	1/32	3.5	2.6	43
	1/64	1.2	1/16	2.8	4.1	50	1.0	1/32	2.3	3.9	39	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.1	26
	1/256	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.8	25	.4	------	0.9	1.4	17	.2	------	0.5	0.8	10
Secondary	1	1.2	1/16	2.8	3.8	47	1.0	1/32	2.3	3.2	39	.8	1/32	1.9	2.8	34	.6	1/32	1.4	2.1	26
	1/4	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.0	25	.4	------	0.9	1.4	17	.2	------	0.5	0.8	10
	1/16	.5	------	1.2	1.7	28	.3	------	0.7	1.1	13	.1	------	.2	0.4	5	0	------	------	0	------

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 gm/cm^3 (147 lbs/ft^3).

Table 3

SHIELDING REQUIREMENTS FOR DENTAL OFFICES AND ADJACENT AREAS FOR 70 KVP OPERATION

(Lead Equivalent. Refer to Table 12, Appendix A)

Workload	Type of Area to be Protected	Name of Barrier	Distance From Tube to Occupied Area: 3 feet	5 feet	7 feet	10 feet	14 feet
			mm	*mm*	*mm*	*mm*	*mm*
1,200 ma-sec/wk. or 12—2 second exposures/day at 10 ma	Controlled Primary	Wall	0.25	0.15	0.1	0.05	0.0
		Floor or ceiling	0.1	0.05	0.0	0.0	0.0
	Controlled Secondary	Wall, floor or ceiling	0.05	0.0	0.0	0.0	0.0
	Uncontrolled Primary	Wall	0.55	0.4	0.3	0.25	0.2
		Floor or ceiling	0.35	0.25	0.2	0.1	0.05
	Uncontrolled Secondary	Wall, floor or ceiling	0.25	0.15	0.1	0.05	0.0
2,500 ma-sec/wk. or 25—2 second exposures/day at 10 ma	Controlled Primary	Wall	0.3	0.2	0.15	0.1	0.05
		Floor or ceiling	0.15	0.1	0.05	0.0	0.0
	Controlled Secondary	Wall, floor or ceiling	0.1	0.0	0.0	0.0	0.0
	Uncontrolled Primary	Wall	0.7	0.5	0.4	0.3	0.25
		Floor or ceiling	0.45	0.3	0.25	0.2	0.1
	Uncontrolled Secondary	Wall, floor or ceiling	0.3	0.2	0.15	0.1	0.05
5,000 ma-sec/wk. or 50—2 second exposures/day at 10 ma	Controlled Primary	Wall	0.4	0.3	0.2	0.15	0.1
		Floor or ceiling	0.25	0.15	0.1	0.05	0.0
	Controlled Secondary	Wall, floor or ceiling	0.15	0.1	0.0	0.0	0.0
	Uncontrolled Primary	Wall	0.8	0.65	0.5	0.4	0.3
		Floor or ceiling	0.6	0.4	0.3	0.25	0.2
	Uncontrolled Secondary	Wall, floor or ceiling	0.4	0.3	0.2	0.15	0.1

Table 4

SHIELDING REQUIREMENTS FOR DENTAL OFFICES AND ADJACENT AREAS FOR 100 KVP OPERATION

(Lead Equivalent. Refer to Table 12, Appendix A)

Workload	Type of Area to be Protected	Name of Barrier	Distance From Tube to Occupied Area				
			3 feet	5 feet	7 feet	10 feet	14 feet
			mm	*mm*	*mm*	*mm*	*mm*
500 ma-sec/wk. or 10—1 second exposures/day at 10 ma	Controlled Primary	Wall	0.4	0.2	0.1	0.0	0.0
		Floor or ceiling	0.15	0.05	0.0	0.0	0.0
	Controlled Secondary	Wall, floor or ceiling	0.0	0.0	0.0	0.0	0.0
	Uncontrolled Primary	Wall	1.0	0.7	0.5	0.35	0.25
		Floor or ceiling	0.65	0.35	0.25	0.15	0.05
	Uncontrolled Secondary	Wall, floor or ceiling	0.4	0.2	0.1	0.0	0.0
1,000 ma-sec/wk. or 20—1 second exposures/day at 10 ma	Controlled Primary	Wall	0.55	0.35	0.2	0.1	0.0
		Floor or ceiling	0.25	0.1	0.0	0.0	0.0
	Controlled Secondary	Wall, floor or ceiling	0.1	0.0	0.0	0.0	0.0
	Uncontrolled Primary	Wall	1.2	0.9	0.7	0.5	0.35
		Floor or ceiling	0.8	0.5	0.35	0.25	0.15
	Uncontrolled Secondary	Wall, floor or ceiling	0.55	0.35	0.2	0.1	0.0
2,000 ma-sec/wk. or 40—1 second exposures/day at 10 ma	Controlled Primary	Wall	0.7	0.4	0.3	0.15	0.05
		Floor or ceiling	0.35	0.15	0.1	0.0	0.0
	Controlled Secondary	Wall, floor or ceiling	0.15	0.05	0.0	0.0	0.0
	Uncontrolled Primary	Wall	1.35	1.0	0.85	0.6	0.45
		Floor or ceiling	0.9	0.65	0.45	0.3	0.2
	Uncontrolled Secondary	Wall, floor or ceiling	0.7	0.4	0.3	0.15	0.05

Table 5

SHIELDING REQUIREMENTS FOR BUSY 100 KVP THERAPEUTIC INSTALLATIONS

(W = 4,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
or controlled areas:																										
Primary	1	2.3	3/32	5.4	7.1	87	2.0	3/32	4.7	6.3	77	1.8	1/16	4.2	5.7	70	1.6	1/16	3.7	5.2	64	1.4	1/16	3.3	4.6	56
	1/4	1.8	1/16	4.2	5.7	70	1.6	1/16	3.7	5.2	64	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42
	1/16	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.1	26
Secondary	1	1.3	1/16	3.0	4.3	53	1.1	1/32	2.6	3.7	45	0.9	1/32	2.1	3.1	38	.7	1/32	1.6	2.4	29	.5	1/32	1.2	1.8	22
or environs:																										
Primary	1	3.2	1/8	7.5	9.2	113	2.9	1/8	6.8	8.5	104	2.7	1/8	6.3	8.0	98	2.4	3/32	5.6	7.3	89	2.2	3/32	5.1	6.8	83
	1/4	2.7	1/8	6.3	8.0	98	2.4	3/32	5.6	7.3	89	2.2	3/32	5.1	6.8	83	1.9	1/16	4.4	6.0	74	1.7	1/16	4.0	5.5	67
	1/16	2.2	3/32	5.1	6.8	83	1.9	1/16	4.4	6.0	74	1.7	1/16	4.0	5.5	67	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49
	1/64	1.7	1/16	4.0	5.5	67	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42	0.8	1/32	1.9	2.8	34
	1/256	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.1	26	.5	1/32	1.2	1.8	23
Secondary	1	2.1	3/32	4.9	6.6	81	1.8	1/16	4.2	5.7	70	1.6	1/16	3.7	5.2	64	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49
	1/4	1.6	1/16	3.7	5.2	64	1.4	1/16	3.3	4.6	56	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42	0.8	1/32	1.9	2.8	34
	1/16	1.2	1/16	2.8	4.0	49	1.0	1/32	2.3	3.4	42	0.8	1/32	1.9	2.8	34	0.6	1/32	1.4	2.1	26	.5	1/32	1.2	1.8	22

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

Table 6

SHIELDING REQUIREMENTS FOR BUSY 150 KVP THERAPEUTIC INSTALLATIONS

(W = 4,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
r controlled areas:		*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
Primary	1	3.1	1/8	7.2	10.4	127	2.9	1/8	6.8	10.0	123	2.5	3/32	5.8	8.8	108	2.3	3/32	5.4	8.2	100	2.0	3/32	4.7	7.2	88
	1/4	2.5	3/32	5.8	8.8	108	2.3	3/32	5.4	8.2	100	2.3	3/32	4.7	7.2	88	1.8	1/16	4.2	6.5	80	1.5	1/16	3.5	5.4	66
	1/16	2.0	3/32	4.7	7.2	88	1.8	1/16	4.2	6.5	80	1.5	1/16	3.5	5.4	66	1.3	1/16	3.0	4.7	58	1.1	1/32	2.6	3.9	48
Secondary	1	1.7	1/16	4.0	6.1	75	1.5	1/16	3.5	5.4	66	1.2	1/16	2.8	4.3	53	1.0	1/32	2.3	4.3	53	0.8	1/32	1.9	2.9	36
r environs:																										
Primary	1	4.1	5/32	9.6	13.3	163	3.9	5/32	9.1	12.8	157	3.5	5/32	8.2	11.6	142	3.3	1/8	7.7	11.1	136	3.0	1/8	7.0	10.2	125
	1/4	3.5	5/32	8.2	11.6	142	3.3	1/8	7.7	11.1	136	3.0	1/8	7.0	10.2	125	2.8	1/8	6.5	9.7	119	2.4	3/32	5.6	8.5	104
	1/16	3.0	1/8	7.0	10.2	125	2.8	1/8	6.5	9.7	119	2.4	3/32	5.6	8.5	104	2.2	3/32	5.1	7.8	96	1.8	1/16	4.2	6.5	80
	1/64	2.4	3/32	5.6	8.5	104	2.2	3/32	5.1	7.8	96	1.8	1/16	4.2	6.5	80	1.6	1/16	3.7	5.8	71	1.3	1/16	3.0	4.7	58
	1/256	1.8	1/16	4.2	6.5	80	1.6	1/16	3.7	5.8	71	1.3	1/16	3.0	4.7	58	1.1	1/32	2.6	3.9	48	0.8	1/32	1.9	2.9	36
Secondary	1	2.6	3/32	6.1	9.1	111	2.4	3/32	5.6	8.5	104	2.0	3/32	4.7	7.2	88	1.8	1/16	4.2	6.5	80	1.4	1/16	3.3	5.8	62
	1/4	2.0	3/32	4.7	7.2	88	1.8	1/16	4.2	6.5	80	1.4	1/16	3.3	5.1	62	1.2	1/16	2.8	4.3	53	0.9	1/32	2.1	4.1	39
	1/16	1.4	1/16	3.3	5.1	62	1.2	1/16	2.8	4.3	53	0.9	1/32	2.1	3.2	39	0.7	1/32	1.6	2.5	31	.5	1/32	1.2	2.3	22

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm^3 (147 lb/ft^3).

Table 7

SHIELDING REQUIREMENTS FOR BUSY 200 KVP THERAPEUTIC INSTALLATIONS

(W = 40,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
For controlled areas:																										
Primary	1	6.4	1/4	14.9	16.7	205	5.9	1/4	13.7	15.8	194	5.4	7/32	12.6	14.8	181	4.9	3/16	11.4	13.7	168	4.4	3/16	10.3	12.7	156
	1/4	5.4	7/32	12.6	14.8	181	4.9	3/16	11.4	13.7	168	4.4	3/16	10.3	12.7	156	3.9	5/32	9.1	11.6	142	3.4	1/8	7.9	10.5	129
	1/16	4.4	3/16	10.3	12.7	156	3.9	5/32	9.1	11.6	142	3.4	1/8	7.9	10.5	129	3.0	1/8	7.0	9.6	118	2.6	3/32	6.1	8.5	104
Secondary	1	4.1	5/32	9.6	12.1	148	3.6	5/32	8.4	11.0	135	3.1	1/8	7.2	9.8	120	2.6	3/32	6.1	8.5	104	2.2	3/32	5.1	7.4	91
For environs:																										
Primary	1	8.1	11/32	18.9	19.9	244	7.6	5/16	17.7	19.0	233	7.1	9/32	16.5	18.0	221	6.6	9/32	15.4	17.1	209	6.1	1/4	14.2	16.2	198
	1/4	7.1	9/32	16.5	18.0	221	6.6	9/32	15.4	17.1	209	6.1	1/4	14.2	16.2	198	5.6	7/32	13.0	15.2	186	5.1	7/32	11.9	14.2	174
	1/16	6.1	1/4	14.2	16.2	198	5.6	7/32	13.0	15.2	186	5.1	7/32	11.9	14.2	174	4.6	3/16	10.7	13.1	160	4.1	5/32	9.6	12.1	148
	1/64	5.1	7/32	11.9	14.2	174	4.6	3/16	10.7	13.1	160	4.1	5/32	9.6	12.1	148	3.6	5/32	8.4	11.0	135	3.2	1/8	7.5	10.0	123
	1/256	4.1	5/32	9.6	12.1	148	3.6	5/32	8.4	11.0	135	3.2	1/8	7.5	10.0	123	2.7	1/8	6.3	8.8	108	2.3	3/32	5.4	7.9	94
Secondary	1	5.6	7/32	13.0	15.2	186	5.1	7/32	11.9	14.2	174	4.6	3/16	10.7	13.1	160	4.1	5/32	9.6	12.1	148	3.6	5/32	8.4	11.0	135
	1/4	4.6	3/16	10.7	13.1	160	4.1	5/32	9.6	12.1	148	3.6	5/32	8.4	11.0	135	3.2	1/8	7.5	10.0	123	2.7	1/8	6.3	8.8	108
	1/16	3.6	5/32	8.4	11.0	135	3.2	1/8	7.5	10.0	123	2.7	1/8	6.3	8.8	108	2.3	3/32	5.4	7.7	94	1.7	1/16	4.0	6.7	74

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm^3 (147 lb/ft^3).

Table 8

SHIELDING REQUIREMENTS FOR BUSY 250 KVP THERAPEUTIC INSTALLATIONS

(W = 40,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)				
		Lead[b]			Concrete[b]		Lead[b]			Concrete[b]		Lead[b]			Concrete[b]		Lead[b]			Concrete[b]		Lead[b]			Concrete[b]	
For controlled areas:		*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
Primary	1	11.3	15/32	26.4	19.3	236	10.4	7/16	24.3	18.0	221	9.5	3/8	22.2	16.8	206	8.6	11/32	20.1	15.6	191	7.7	5/16	18.0	14.4	176
	1/4	9.5	3/8	22.2	16.8	206	8.6	11/32	20.1	15.6	191	7.7	5/16	18.0	14.4	176	6.8	9/32	15.9	13.2	162	6.0	1/4	14.0	12.0	147
	1/16	7.7	5/16	18.0	14.4	176	6.8	9/32	15.9	13.2	162	6.0	1/4	14.0	12.0	147	5.2	7/32	12.1	10.8	132	4.4	3/16	10.3	9.6	118
Secondary	1	6.4	1/4	14.9	12.6	154	5.7	7/32	13.3	11.5	141	5.0	7/32	11.7	10.5	129	4.2	5/32	9.8	9.4	115	3.5	5/32	8.2	8.3	102
For environs:																										
Primary	1	13.9	9/16	32.4	22.9	281	13.0	17/32	30.3	21.6	265	12.1	1/2	28.2	20.4	250	11.2	15/32	26.1	19.2	235	10.3	13/32	24.0	18.0	221
	1/4	12.1	1/2	28.2	20.4	250	11.2	15/32	26.1	19.2	235	10.3	13/32	24.0	18.0	221	9.4	3/8	21.9	16.7	205	8.5	11/32	19.8	15.5	190
	1/16	10.3	13/32	24.0	18.0	221	9.4	3/8	21.9	16.7	205	8.5	11/32	19.8	15.5	190	7.6	5/16	17.7	14.3	175	6.7	9/32	15.6	13.0	159
	1/64	8.5	11/32	19.8	15.5	190	7.6	5/16	17.7	14.3	175	6.7	9/32	15.6	13.0	159	5.9	1/4	13.8	11.8	145	5.1	7/32	11.9	10.7	131
	1/256	6.7	9/32	15.6	13.0	159	5.9	1/4	13.8	11.8	145	5.1	7/32	11.9	10.7	131	4.4	3/16	10.3	9.6	118	3.7	5/32	8.6	8.5	104
Secondary	1	8.8	11/32	20.5	16.0	196	8.0	5/16	18.7	14.8	181	7.3	9/32	17.0	13.8	169	6.5	1/4	15.2	12.7	156	5.8	1/4	13.5	11.7	143
	1/4	7.3	9/32	17.0	13.8	169	6.5	1/4	15.2	12.7	156	5.8	1/4	13.5	11.7	143	5.0	7/32	11.7	10.5	129	4.4	3/16	10.3	9.6	118
	1/16	5.8	1/4	13.5	11.7	143	5.0	7/32	11.7	10.5	129	4.4	3/16	10.3	9.6	118	3.8	5/32	8.9	8.8	107	3.2	1/8	7.5	7.7	94

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm^3 (147 lb/ft^3).
[b]Constant potentials may require 15 to 25 percent larger thicknesses of lead and 5 to 15 percent larger thicknesses of concrete than those given here for pulsating potentials.

Table 9

SHIELDING REQUIREMENTS FOR BUSY 300 KVP THERAPEUTIC INSTALLATIONS

(W = 40,000 ma-min/week)

Type of barrier	*UT*	Distance from tube to occupied area																								
		5 ft (1.52 m)					7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)				
		Lead[a]			Concrete[a]		Lead[a]			Concrete[a]		Lead[a]			Concrete[a]		Lead[a]			Concrete[a]		Lead[a]			Concrete[a]	
		mm	*in.*	*psf*[b]	*in.*	*psf*[b]	*mm*	*in.*	*psf*[b]	*in.*	*psf*[b]	*mm*	*in.*	*psf*[b]	*in.*	*psf*[b]	*mm*	*in.*	*psf*[b]	*in.*	*psf*[b]	*mm*	*in.*	*psf*[b]	*in.*	*psf*[b]
For controlled areas:																										
Primary	1	17.8	11/16	41.3	21.6	265	16.3	21/32	37.8	20.5	251	14.9	19/32	34.6	19.3	237	13.5	17/32	31.3	18.0	221	12.1	15/32	28.1	16.8	206
	1/4	14.9	19/32	34.4	19.3	237	13.5	17/32	31.1	18.0	221	12.1	15/32	28.1	16.8	206	10.7	7/16	25.1	15.7	192	9.4	3/8	22.1	14.4	176
	1/16	12.1	15/32	27.9	16.8	206	10.7	13/32	24.9	15.7	192	9.4	3/8	22.0	14.4	172	8.3	5/16	19.3	13.2	162	7.0	9/32	16.3	12.0	147
Secondary	1	10.6	13/32	24.6	13.2	162	9.4	3/8	21.9	12.0	147	8.1	5/16	19.1	10.8	132	6.8	9/32	15.8	9.6	118	5.4	7/32	12.6	8.4	103
For environs:																										
Primary	1	22.1	7/8	51.3	25.6	314	20.6	13/16	47.9	24.5	300	19.2	3/4	44.6	23.3	285	17.8	23/32	41.3	22.0	270	16.4	21/32	38.1	20.8	255
	1/4	19.2	3/4	44.4	23.3	286	17.8	11/16	41.1	22.0	270	16.4	21/32	38.1	20.8	255	15.1	5/8	35.1	19.7	241	13.8	17/32	32.0	18.4	225
	1/16	16.4	21/32	37.8	20.8	255	15.1	19/32	34.9	19.7	241	13.8	17/32	32.0	18.4	221	12.6	1/2	29.2	17.3	211	11.2	7/16	26.2	16.0	196
	1/64	13.8	17/32	31.7	18.4	226	12.6	1/2	28.8	17.3	212	11.2	7/16	26.0	16.0	191	10.0	13/32	23.2	14.9	181	8.6	11/32	20.2	13.6	167
	1/256	11.2	7/16	25.8	16.0	196	10.0	3/8	22.6	14.9	183	8.6	11/32	20.0	13.6	162	7.4	5/16	17.2	12.4	152	6.1	1/4	14.2	11.2	137
Secondary	1	14.9	19/32	34.6	17.2	211	13.7	17/32	31.8	16.0	196	12.3	1/2	28.8	14.8	181	11.1	7/16	25.8	13.6	167	9.7	3/8	22.5	12.4	152
	1/4	12.3	1/2	28.5	14.8	181	11.1	7/16	25.8	13.6	167	9.7	3/8	22.7	12.4	152	8.5	11/32	19.8	11.2	137	7.1	9/32	16.5	10.0	123
	1/16	9.7	3/8	22.5	12.4	152	8.5	11/32	19.8	11.2	137	7.1	9/32	16.7	10.0	123	5.9	1/4	13.7	8.8	108	4.5	3/16	10.5	7.6	93

[a]Constant potentials may require 15 to 25 percent larger thicknesses of lead and 5 to 15 percent larger thicknesses of concrete than those given here for pulsating potentials.
[b]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

Table 10

SHIELDING REQUIREMENTS FOR BUSY 1,000 KVCP THERAPEUTIC INSTALLATIONS

(W = 4,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.26 m)					20 ft (6.10 m)					30 ft (9.15 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
For controlled area:																										
Primary	1	130	5.1	300	32	390	120	4.7	280	30	370	115	4.5	270	28.5	350	105	4.1	240	26.5	330	100	3.9	230	25	310
	1/4	115	4.5	270	28.5	350	105	4.1	240	26.5	330	100	3.9	230	25	310	90	3.5	200	23	280	85	3.3	200	21.5	260
	1/16	100	3.9	230	25	310	90	3.5	210	23	280	85	3.3	200	21.5	260	75	3.0	180	19.5	240	70	2.8	170	18	220
Secondary	1	45	1.8	104	14.7	180	36.5	1.4	85	13.3	163	28.5	1.1	66	12.0	147	21	0.8	49	10.5	129	14.5	0.6	34	7.0	86
	1/4	28.5	1.1	66	11.9	146	21	0.8	49	10.5	129	14.5	0.6	34	7.5	92	11	0.4	25	6.0	74	5	0.2	12	4.5	55
	1/16	16	0.6	37	7.5	92	11	0.4	25	6.0	74	5.0	0.2	12	4.5	55	4	0.2	9	3.1	38	0	0	----	0	----
For environs:																										
Primary	1	160	6.3	370	38	470	145	5.7	330	36	440	140	5.5	320	34.5	420	130	5.1	300	32.5	400	125	4.9	290	31	380
	1/4	140	5.5	320	34.5	420	130	5.1	300	32.5	400	125	4.9	290	31	380	115	4.5	270	29	360	110	4.3	250	27.5	340
	1/16	125	4.9	290	31	380	115	4.5	270	29	360	110	4.3	250	27.5	340	100	3.9	230	25.5	310	95	3.5	210	24	290
Secondary	1	71.5	2.8	166	19.5	239	63	2.5	146	18.0	221	55	2.2	128	16.6	203	47	1.9	109	13.5	165	37.5	1.5	87	13.5	165
	1/4	55	2.2	128	16.1	197	47	1.9	109	13.5	165	39	1.5	91	13.8	169	31	1.2	72	12.4	152	22	0.9	51	9.0	110
	1/16	39.5	1.6	92	13.8	169	31	1.2	72	12.4	152	23	0.9	54	11.0	135	18.5	0.7	43	9.5	116	11.5	0.5	27	6.0	74

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

Table 11

SHIELDING REQUIREMENTS FOR BUSY 2,000 KVCP THERAPEUTIC INSTALLATIONS

(W = 2,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.23 m)					20 ft (6.10 m)					30 ft (9.15 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
For controlled area:																										
Primary	1	235	9.3	550	50	610	225	8.9	520	47	580	210	8.3	490	45	550	200	7.9	470	42	520	185	7.3	430	40	490
	1/4	210	8.3	490	45	550	200	7.9	470	42	520	185	7.3	430	40	490	175	6.9	410	37	460	160	6.3	370	35	430
	1/16	185	7.3	430	40	490	175	6.9	410	37	460	160	6.3	370	35	430	150	5.9	350	32	390	135	5.3	320	30	370
Secondary	1	67	2.6	156	15	300	54	2.2	128	14	181	43	1.7	100	12	164	31	1.2	72	10	147	19	0.6	36	8.2	126
	1/4	43	1.7	100	12	163	31	1.2	72	10	147	22	0.8	47	8.5	129	13	0.5	30	7	113	8	0.3	15	5.0	93
	1/16	22	0.9	54	9	131	13	0.5	30	7	110	8	0.3	17	5.4	83	5	0.2	10	4	48	2	0.1	4	2.1	27
For environs:																										
Primary	1	280	11.1	650	58	710	265	10.5	620	55	670	255	10.1	590	53	650	240	9.5	560	50	610	230	9.1	540	48	590
	1/4	255	10.1	590	53	650	240	9.5	560	50	610	235	9.1	540	48	590	215	8.5	500	45	550	205	8.1	480	43	530
	1/16	230	9.1	540	48	590	215	8.5	500	45	550	205	8.1	480	43	530	190	7.5	440	40	490	180	7.1	420	38	470
Secondary	1	107	4.2	302	22	298	94	3.7	221	20	267	83	3.3	193	18	238	71	2.8	165	16	208	57	2.4	142	14	172
	1/4	83	3.3	193	18	224	71	2.8	165	16	195	59	2.3	137	14	187	47	1.9	109	12	169	32	1.3	76	10	149
	1/16	59	2.2	128	14	187	47	1.9	109	12	169	36	1.4	81	11	153	24	1.0	60	9	136	14	0.5	31	7	114

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

Table 12

SHIELDING REQUIREMENTS FOR BUSY 3,000 KVCP THERAPEUTIC INSTALLATIONS

(W = 2,000 ma-min/week)

Type of barrier	UT	Distance from tube to occupied area																								
		7 ft (2.13 m)					10 ft (3.05 m)					14 ft (4.23 m)					20 ft (6.10 m)					30 ft (9.15 m)				
		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete		Lead			Concrete	
		mm	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]	*mm*	*in.*	*psf*[a]	*in.*	*psf*[a]
For controlled area:																										
Primary	1	310	12.2	725	64	780	295	11.6	690	61	745	280	11.0	655	58	710	265	10.4	620	55	670	249	9.8	580	52	635
	1/4	280	11.0	655	58	710	265	10.4	620	55	670	250	9.8	585	52	635	235	9.3	550	50	610	219	9.6	510	46	560
	1/16	250	9.8	585	52	635	235	9.3	550	50	610	220	8.7	515	47	575	205	8.1	480	44	540	188	7.4	440	41	500
Secondary	1	93	----	----	19.3	----	78	----	----	16.9	----	63	----	----	14.5	----	48	----	----	12.5	----	31	----	----	10.4	----
	1/4	63	----	----	14.5	----	48	----	----	12.5	----	34	----	----	10.7	----	22	----	----	9.0	----	13	----	----	7.1	----
	1/16	34	----	----	10.7	----	22	----	----	9.0	----	14	----	----	7.4	----	9	----	----	5.8	----	6	----	----	4.0	----
or environs:																										
Primary	1	358	14.1	840	73	890	343	13.5	800	70	855	329	13.0	770	68	830	314	12.4	735	65	795	298	11.7	700	61	745
	1/4	328	12.9	710	68	830	314	12.4	735	65	795	299	11.8	700	62	755	285	11.2	665	59	720	268	10.6	625	56	685
	1/16	299	11.8	700	62	755	285	11.2	665	59	720	270	10.6	630	56	685	255	10.0	595	53	650	238	9.4	560	50	610
	1/64	270	10.6	630	56	685	255	10.0	595	53	650	240	9.5	560	50	610	225	8.9	525	48	585	210	8.3	490	44	540
	1/256	240	9.5	560	50	610	225	8.9	525	48	585	210	8.3	490	44	540	195	7.7	455	42	510	180	7.1	420	29	475
Secondary	1	143	----	----	28.8	----	128	----	----	25.9	----	113	----	----	22.9	----	98	----	----	20.3	----	80	----	----	17.1	----
	1/4	113	----	----	22.9	----	98	----	----	20.3	----	83	----	----	17.6	----	68	----	----	15.2	----	50	----	----	12.8	----
	1/16	83	----	----	17.6	----	68	----	----	15.2	----	53	----	----	13.2	----	38	----	----	11.3	----	23	----	----	9.3	----

[a]Pounds per square foot computed from millimeters of lead or inches of concrete and a concrete density of 2.35 g/cm³ (147 lb/ft³).

APPENDIX C

RAD-A—Current occupational external radiation exposure

Form RAD-A
1965

APPENDIX C

WISCONSIN STATE BOARD OF HEALTH

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on the Back

IDENTIFICATION

1. NAME (PRINT—LAST, FIRST, AND MIDDLE)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (MONTH, DAY, YEAR)	4. AGE IN FULL YEARS (N)

OCCUPATIONAL EXPOSURE

5. DOSE RECORDED FOR (SPECIFY: WHOLE BODY; SKIN OF WHOLE BODY; OR HANDS AND FOREARMS, FEET AND ANKLES.)	6. PERMISSIBLE DOSE AT BEGINNING OF PERIOD COVERED BY THIS SHEET	7. METHOD OF MONITORING (E.G., FILM BADGE—FB; POCKET CHAMBER—PC; CALCULATIONS—CALC.) X-RAY OR GAMMA________ BETA______ NEUTRONS______

8. PERIOD OF EXPOSURE (FROM—TO)	DOSE FOR THE PERIOD (REM)				13. RUNNING TOTAL FOR CALENDAR QUARTER (REM)
	9. X-RAY OR GAMMA	10. BETA	11. NEUTRON	12. TOTAL	

LIFETIME ACCUMULATED DOSE

14. PREVIOUS TOTAL REM	15. TOTAL DOSE RECORDED ON THIS SHEET REM	16. TOTAL ACCUMULATED DOSE REM	17. PERM. ACC. DOSE 5(N—18) = REM	18. PERMISSIBLE DOSE REM

19. NAME OF LICENSEE OR REGISTRANT

RADIATION PROTECTION DIVISION
WISCONSIN STATE BOARD OF HEALTH
MADISON, WISCONSIN 53701

INSTRUCTIONS FOR PREPARATION OF FORM RAD-A

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form, is required pursuant to Section H 57.03 (3) (b) (c) (d) of the Radiation Protection Code as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section H 57.03 (3) (a). Note that a separate copy of this form is to be used for recording external exposure to whole body; and skin of whole body; or hands and forearms, feet and ankles as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

IDENTIFICATION

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Enter the age in full years. This is called "N" when used in calculating the Maximum Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

OCCUPATIONAL EXPOSURE

Item 5. Use separate form to record exposure to whole body; skin of whole body; hands and forearms, feet and ankles—Specify in Item 5.

If an individual receives a radiation dose to the skin of the whole body from radiation of half-value layer less than 5 cm. of tissue, the dose to the skin of the whole body should be recorded on a separate form, unless the dose to the skin of the whole body as indicated by personnel monitoring devices has been included as dose to the whole body on a form maintained for recording whole body exposures.

If an individual receives a radiation dose to the hands and forearms, or feet and ankles, the dose to those portions of the body should be recorded on separate forms unless the dose to those parts of the body as indicated by personnel monitoring devices have been included as doses to the whole body on a form maintained for recording whole body exposure.

"Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

Item 6. The permissible dose is taken from (a) previous records of exposure recorded by the licensee or registrant (i.e., Item 18 of a previous Form RAD-A); or if the licensee or registrant chooses not to refer to the previous exposure, the whole body dose must be limited to 1.25 rem per quarter.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, a film badge issued Monday morning, August 4, 1958, and picked up Friday, August 15, 1958, would be indicated 8/4/58–8/15/58.

Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known. A description of the method of analyzing the monitoring results in terms of dose is to be maintained in conjunction with these records. In any case where the dose for a calendar quarter is less than 10% of the value specified in Table 1, Appendix A, the phrase "less than 10%" may be entered in lieu of a numerical value.

Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters.

LIFETIME ACCUMULATED DOSE (Whole Body)

NOTE: If the licensee or registrant chooses to keep the individual's exposure below that permitted in Table 1, Appendix A, Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 should not exceed 1¼ rem as indicated in Item 6. Complete Items 14 through 18 when body of record in full. Values in Column 13, when in the middle of the calendar quarter, and Item 18 must be brought forward to next sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., Item 16 if Form RAD-A.)

Item 15. Enter the sum of all totals under Item 12.

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (MPD) in rem for the WHOLE BODY. Use the value for N from Item 4. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, Age 32: $N = 32$, $MPD = 5(32 - 18) = 70$ rem).

Item 18. Determine the Permissible Dose by subtracting Item 16 from Item 17. The Permissible Dose is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

Item 19. Self-explanatory.

H 57.15 Concentrations in effluents to unrestricted areas. (1) A user of a radiation installation shall not possess, use or transfer radioactive material so as to release to an unrestricted area radioisotopes in concentrations which exceed the limits specified in Appendix D, Table II of this part. For purposes of this section concentrations may be averaged over a period not greater than one year.

(2) For the purposes of this section the concentration limits in Appendix D, Table II of this part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(3) In addition to limiting concentrations in effluent streams the department may limit quantities of radioactive materials released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third the concentration of radioactive materials specified in Appendix D, Table II of this section.

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air (μc/ml)	Water (μc/ml)	Air (μc/ml)	Water (μc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Am 242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}	----------	1×10^{-4}	----------
	A 41	Sub	2×10^{-6}	----------	4×10^{-8}	----------
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	2×10^{-11}	7×10^{-4}	7×10^{-13}	2×10^{-5}
		I	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}	----------	1×10^{-6}	----------
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Se 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	3×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	(T/2 = 9.2 hrs)	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
	(T/2 = 13 yrs)	I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I Column 1 Air (μc/ml)	Table I Column 2 Water (μc/ml)	Table II Column 1 Air (μc/ml)	Table II Column 2 Water (μc/ml)
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	8×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		I	5×10^{-5}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	----------	4×10^{-5}	----------
Indium (49)	In 113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
		I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I 126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}
Iodine (53)	I 134	I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr 85m	Sub	6×10^{-6}	----------	1×10^{-7}	----------
	Kr 85	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Kr 87	Sub	1×10^{-6}	----------	2×10^{-8}	----------
	Kr 88	Sub	1×10^{-6}	----------	2×10^{-8}	----------
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	S	4×10^{-7}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-3}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Pt 197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-4}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-3}
	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu 244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}

STANDARDS FOR PROTECTION AGAINST RADIATION APPENDIX D

Concentrations in Air and Water Above Natural Background (See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Potassium (19)	K 42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}	----------	1×10^{-8}	----------
	Rn 222	S	1×10^{-7}	----------	3×10^{-9}	----------
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}

STANDARDS FOR PROTECTION AGAINST RADIATION APPENDIX D

Concentrations in Air and Water Above Natural Background (See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	8×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th 232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
		I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th natural	S	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}

STANDARDS FOR PROTECTION AGAINST RADIATION APPENDIX D

Concentrations in Air and Water Above Natural Background (See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U 232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
		I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U 235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U 238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U natural	S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
		I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-5}	----------	4×10^{-7}	----------
	Xe 133	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Xe 133m	Sub	1×10^{-5}	----------	3×10^{-7}	----------
	Xe 135	Sub	4×10^{-6}	----------	1×10^{-7}	----------
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay						

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]	Table I Column 1 Air (uc/ml)	Table I Column 2 Water (uc/ml)	Table II Column 1 Air (uc/ml)	Table II Column 2 Water (uc/ml)
mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	Sub	1×10^{-6}	......	3×10^{-8}	......
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission		6×10^{-13}	4×10^{-7}	2×10^{-11}	3×10^{8}

[1]Soluble (S); Insoluble (I).

[2]"Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix D for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixturer may not exceed "I" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's, are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \frac{C_C}{MPC_C} = 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix D shall be:

a. For purposes of Table I, Col. 1—6×10^{-12}

b. For purposes of Table I, Col. 2—4×10^{-7}

c. For purposes of Table II, Col. 1—2×10^{-14}

d. For purposes of Table II, Col. 2—3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix D for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix D are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix D for any radionuclide which is not known to be absent from the mixture; or

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

c. Element (atomic number) and isotope	Table I Column 1 Air (uc/ml)	Table I Column 2 Water (uc/ml)	Table II Column 1 Air (uc/ml)	Table II Column 2 Water (uc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Thnat, Cm 248, Cf 254, and Fm 256 are not present		9×10^{-5}		3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Thnat, Cm 248 Cf 254, and Fm 256 are not present		6×10^{-5}		2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present		2×10^{-5}		6×10^{-7}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present		3×10^{-1}		1×10^{-7}
**If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 240, and Bk 249 are not present	3×10^{-9}		1×10^{-10}	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}		1×10^{-12}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 251 are not present	3×10^{-12}		1×10^{-13}	

**ERRATUM: This line should read: "210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not"

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1—1×10^{-10} uc/ml gross alpha activity; or 2.5×10^{-11} uc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-12} uc/ml gross alpha activity; or 8×10^{-12} uc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix D (MPC_A) does not exceed 1/10,

(i.e. $\frac{C_A}{MPC_A} = \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed ¼ i.e.

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \ldots\ldots\ldots\ldots ¼).$$

History: Cr. Register, September, 1971, No. 189, eff. 10-1-71.

H 57.16 Definitions as used in sections H 57.17 through H 57.28. (1) "CONTAMINANT" means any physical, chemical, biological or radiological substance or matter in water.

(2) "MAXIMUM CONTAMINANT LEVEL" means the maximum permissible level of a contaminant in water which is delivered to the consumer service outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

(3) "PERSON" means an individual, corporation, company, association, cooperative, trust, institution, partnership, state, municipality or federal agency.

(4) "PUBLIC WATER SYSTEM" means a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Such system includes:

(a) Any collection, treatment, storage and distribution facilities under control of the operator of such system and used primarily in connection with such system, and

(b) Any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. A public water system is either a "community water system" or a "non-community water system."

1. "Community water system" means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

2. "Non-community water system" means a public water system that is not a community water system.

(5) "SUPPLIER OF WATER" means any person who owns or operates a public water system.

(6) "DOSE EQUIVALENT" means the product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the international commission on radiological units and measurements (ICRU).

(7) "REM" means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or organ system. A milliren (mrem) is 1/1000 of a rem.

(8) "PICOCURIE" (pCi) means that quantity of radioactive material producing 2.22 nuclear transformations per minute.

(9) "GROSS ALPHA PARTICLE ACTIVITY" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.

(10) "MAN-MADE BETA PARTICLE AND PHOTON EMITTERS" means all radionuclides emitting beta particles and/or photons listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, except the daughter products of thorium-232, uranium-235 and uranium-238.

(11) "GROSS BETA PARTICLE ACTIVITY" means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

(12) "DEPARTMENT" means the department of health and social services.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.17 Applicability. The provisions of sections H 57.16 through H 57.28 establish radioactivity regulations which apply to each community water system, unless the community water system meets all of the following conditions:

(1) Consists only of distribution and storage facilities (and does not have any collection and treatment facilities); and

(2) Obtains all of its water from, but is not owned or operated by, a public water system to which such regulations apply; and

(3) Does not sell water to any person; and

(4) Is not a carrier which conveys passengers in interstate commerce.

History: Cr. Register, February 1978, No. 266, eff. 3-1-78.

H 57.18 Maximum contaminant levels for radium-226, radium-228 and gross alpha particle radioactivity in community water systems. The following are the maximum contaminant levels for radium-226, radium-228 and gross alpha particle radioactivity:

(1) Combined radium-226 and radium-228 — 5 pCi/1.

(2) Gross alpha particle activity (including radium-226 but excluding radon and uranium) — 15 pCi/1.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.19 Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems.

(1) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.

(2) Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible

Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended August 1963, U.S. department of commerce. If 2 or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

Table A - Average annual concentrations assumed to produce a total body or organ dose of 4 mrem/year

Radionuclide	Critical Organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.20 Analytical methods for radioactivity. (1) The methods specified in Interim Radiochemical Methodology for Drinking Water, Environmental Monitoring and Support Laboratory, EPA-600/4-75-008, USEPA, Cincinnati, Ohio 45268, or those listed below, are to be used to determine compliance with sections H 57.18 and H 57.19 except in cases where alternative methods have been approved in accordance with section H 57.22.

(a) Gross Alpha and Beta — Method 302 "Gross Alpha and Beta in Water" Standard Methods for the Examination of Water and Wastewater, 13th edition American Public Health Association, New York, New York, 1971.

(b) Total Radium — Method 304 "Radium in Water by Precipitation" ibid.

(c) Radium-226 — Method 305 "Radium-226 by Radon in Water" ibid.

(d) Strontium-89, 90 — Method 303 "Total Strontium and Strontium-90 in Water" ibid.

(e) Tritium — Method 306 "Tritium in Water" ibid.

(f) Cesium-134 — ASTM D-2459 "Gamma Spectrometry in Water," 1975 Annual Book of ASTM Standards, Water and Atmospheric Analysis, Part 31, American Society for Testing and Materials, Philadelphia, PA (1975).

(g) Uranium — ASTM D-2907 "Microquantities of Uranium in Water by Fluorometry," ibid.

(2) When the identification and measurement of radionuclides other than those listed in subsection (1) is required, the following references are to be used, except in cases where alternative methods have been approved in accordance with section H 57.22.

(a) Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions, H. L. Krieger and S. Gold, EPA-R4-73-014. USEPA, Cincinnati, Ohio, May 1973.

(b) HASL Procedure Manual, Edited by John H. Harley, HASL 300, ERDA Health and Safety Laboratory, New York, New York, 1973.

(3) For the purpose of monitoring radioactivity concentrations in drinking water, the required sensitivity of the radioanalysis is defined in terms of a detection limit. The detection limit shall be that concentration which can be counted with a precision of plus or minus 100% at the 95% confidence level (1.96σ where σ is the standard deviation of the net counting rate of the sample).

(a) To determine compliance with section H 57.18 (1) the detection limit shall not exceed 1 pCi/1. To determine compliance with subsection H 57.18(2), the detection limits shall not exceed 3 pCi/1.

(b) To determine compliance with section H 57.19 the detection limits shall not exceed the concentrations listed in Table B.

Table B

Detection Limits for Man-Made Beta Particle and Photon Emitters

Radionuclide	Detection Limit
Tritium	1,000 pCi/1
Strontium-89	10 pCi/1
Strontium-90	2 pCi/1
Iodine-131	1 pCi/1
Cesium-134	10 pCi/1
Gross beta	4 pCi/1
Other radionuclides	1/10 of the applicable limit

(4) To judge compliance with the maximum contaminant levels listed in sections H 57.18 and H 57.19 averages of data shall be used and shall be rounded to the same number of significant figures as the maximum contaminant level for the substance in question.

(5) The publications referred to in this section are available for inspection at the office of the department of health and social services, the secretary of state's office and the office of the revisor of statutes.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.21 Monitoring frequency for radioactivity in community water systems. (1) MONITORING requirements for gross alpha particle activity, radium-226 and radium-228. (a) Initial sampling to determine compliance with section H 57.18 shall begin by June 24, 1979 and the analysis shall be completed by June 24, 1980. Compliance shall be based on the analysis of an annual composite of four consecutive quarterly samples or the average of the analyses of 4 samples obtained at quarterly intervals.

1. A gross alpha particle activity measurement may be substituted for the required radium-226 and radium-228 analysis provided that the measured gross alpha particle activity does not exceed 5 pCi/1 at a confidence level of 95% (1.96σ where σ is the standard deviation of the net counting rate of the sample). In localities where radium-228 may be present in drinking water, the department may require radium-226 and/or radium-228 analyses when the gross alpha particle activity exceeds 2 pCi/1.

2. When the gross alpha particle activity exceeds 5 pCi/1, the same or an equivalent sample shall be analyzed for radium-226. If the concentration of radium-226 exceeds 3 pCi/1, the same or an equivalent sample shall be analyzed for radium-228.

(b) For the initial analysis required by subsection H 57.21 (1) (a), data acquired after June 24, 1976 may be substituted at the discretion of the department.

(c) Suppliers of water shall monitor at least once every 4 years following the procedure required by section H 57.21 (1) (a). At the discretion of the department, when an annual record taken in conformance with section H 57.21 (1) (a) has established that the average annual concentration is less than half the maximum contaminant levels established by section H 57.18, analysis of a single sample may be substituted for the quarterly sampling procedure required by section H 57.21 (1) (a).

1. More frequent monitoring shall be conducted when ordered by the department in the vicinity of mining or other operations which may contribute alpha particle radioactivity to either surface or groundwater sources of drinking water.

2. A supplier of water shall monitor in conformance with section H 57.21 (1) (a) within one year of the introduction of a new water source for a community water system. More frequent monitoring shall be conducted when ordered by the department in the event of possible contamination or when changes in the distribution system or treatment processing occur which may increase the concentration of radioactivity in finished water.

3. A community water system using 2 or more sources having different concentrations of radioactivity shall monitor source water, in addition to water from a free-flowing tap, when required by the department.

4. Monitoring for compliance with section H 57.18 after initial period need not include radium-228 except when required by the department, provided that the average annual concentration of radium-228 has been assayed at least once using the quarterly sampling procedure required by section H 57.21 (1) (a).

5. Suppliers of water shall conduct annual monitoring of any community water system in which the radium-226 concentration exceeds 3 pCi/1, when required by the department.

(d) If the average annual maximum contaminant level for gross alpha particle activity or total radium as set forth in section H 57.18 is exceeded, the supplier of a community water system shall give notice to the department pursuant to section H 57.25 and notify the public as required by section H 57.26. Monitoring at quarterly intervals shall be continued until the annual average concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

(2) MONITORING REQUIREMENTS FOR MAN-MADE RADIOACTIVITY IN COMMUNITY WATER SYSTEMS. (a) By June 24, 1979 systems using surface water sources and serving more than 100,000 persons and such other community water systems as are designated by the department shall be

monitored for compliance with section H 57.19 by analysis of a composite of 4 consecutive quarterly samples or analysis of 4 quarterly samples. Compliance with section H 57.19 may be assumed without further analysis if the average annual concentration of gross beta particle activity is less than 50 pCi/1 and if the average annual concentrations of tritium and strontium-90 are less than those listed in Table A, provided, that if both radionuclides are present the sum of their annual dose equivalents to bone marrow shall not exceed 4 millirem/year.

1. If the gross beta particle activity exceeds 50 pCi/1, an analysis of the sample must be performed to identify the major radioactive constituents present and the appropriate organ and total body doses shall be calculated to determine compliance with section H 57.19.

2. Suppliers of water shall conduct additional monitoring, as required by the department, to determine the concentration of man-made radioactivity in principal watersheds designated by the department.

3. At the discretion of the department suppliers of water utilizing only groundwaters may be required to monitor for man-made radioactivity.

(b) For the initial analysis required by section H 57.21 (2) (a) data acquired since June 24, 1976 may be substituted at the discretion of the department.

(c) After the initial analysis required by section H 57.21 (2) (a) suppliers of water shall monitor at least every 4 years following the procedure given in section H 57.21 (2) (a).

(d) By June 24, 1979 the supplier of any community water system designated by the department as utilizing waters subject to contamination by effluents from nuclear facilities shall initiate quarterly monitoring for gross beta particle and iodine-131 radioactivity and annual monitoring for strontium-90 and tritium.

1. Quarterly monitoring for gross beta particle activity shall be based on the analysis of monthly samples or the analysis of a composite of 3 monthly samples. The former is recommended. If the gross beta particle activity in a sample exceeds 15 pCi/1, the same or an equivalent sample shall be analyzed for strontium-89 and cesium-134. If the gross beta particle activity exceeds 50 pCi/1, an analysis of the sample must be performed to identify the major radioactive constituents present and the appropriate organ and total body doses shall be calculated to determine compliance with section H 57.19.

2. For iodine-131, a composite of 5 consecutive daily samples shall be analyzed once each quarter. As required by the department, more frequent monitoring shall be conducted when iodine-131 is identified in the finished water.

3. Annual monitoring for strontium-90 and tritium shall be conducted by means of the analysis of a composite of 4 consecutive quarterly samples or analysis of 4 quarterly samples.

Note: The latter is recommended procedure.

4. The department may allow the substitution of environmental surveillance data taken in conjunction with a nuclear facility for direct monitoring of man-made radioactivity by the supplier of water where

the department determines such data is applicable to a particular community water system.

(e) If the average annual maximum contaminant level for man-made radioactivity set forth in section H 57.19 is exceeded, the operator of a community water system shall give notice to the department pursuant to section H 57.25 and to the public as required by section H 57.26. Monitoring at monthly intervals shall be continued until the concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.22 Alternative analytical techniques. With the written permission of the department, concurred in by the administrator of the U.S. environmental protection agency, an alternative analytical technique may be employed. An alternative technique shall be acceptable only if it is substantially equivalent to the prescribed test in both precision and accuracy as it relates to the determination of compliance with any maximum contaminant level. The use of the alternative analytical technique shall not decrease the frequency of monitoring required by section H 57.21.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.23 Approved laboratories. For the purpose of determining compliance with sections H 57.17 through H 57.22, samples may be considered only if they have been analyzed by the department's laboratory or a laboratory approved by the department.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.24 Monitoring of consecutive public water systems. When a public water system supplies water to one or more other public water systems, the department of natural resources may modify the monitoring requirements imposed by this section to the extent that the interconnection of the systems justifies treating them as a single system for monitoring purposes. Any modified monitoring shall be conducted pursuant to a schedule specified by the department of natural resources and concurred in by the administrator of the U.S. environmental protection agency.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.25 Reporting requirements. (1) Except where a shorter reporting period is specified in this section, the supplier of water shall report to the department within 40 days following a test, measurement or analysis required to be made by sections H 57.16 through H 57.26, the results of that test, measurement or analysis.

(2) The supplier of water shall report to the department within 48 hours the failure to comply with any primary drinking water regulation (including failure to comply with monitoring requirements) set forth in sections H 57.16 through H 57.26.

(3) The supplier of water is not required to report analytical results to the department when the department performs the analysis and reports the results to the department.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.26 Public notification. Public notification shall be provided as prescribed in section NR 109.81, Wisconsin Administrative Code.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.27 Record maintenance. The supplier of water shall maintain records as prescribed by section NR 109.82, Wisconsin Administrative Code.

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.

H 57.28 Variance and exemptions. Variances and exemptions may be granted from any requirement respecting a maximum contaminant level for radioactivity as prescribed in sections NR 109.90 through NR 109.98, Wisconsin Administrative Code. 11/14/77

History: Cr. Register, February, 1978, No. 266, eff. 3-1-78.