



UNITED STATES
NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555-0001

April 1997

ERRATA

Report Number: NUREG-1492

Report Title: Regulatory Analysis on Criteria for the Release of Patients Administered Radioactive Material
Final Report

Prepared by: Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Date Published: February 1997

Instructions: Please replace pages A.1 and A.2 in Appendix A with the enclosed pages. In Table A.1, the exposure rate constant (R/mCi-h at 1 cm) for Pd-103 implant has been changed from 1.48 to 0.86.

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APPENDIX A

PARAMETERS AND CALCULATIONS FOR DETERMINING RELEASE QUANTITIES AND DOSE RATES FOR RADIONUCLIDES USED IN MEDICINE

Table A.1 Half-Lives and Exposure Rate Constants of Radionuclides Used in Medicine*

Radionuclide	Half-Life (days)	Exposure Rate Constant (R/mCi-h at 1 cm)	Radionuclide	Half-Life (days)	Exposure Rate Constant (R/mCi-h at 1 cm)
Ag-111	7.45	0.15	Pd-103 implant	16.96	0.86**
Au-198	2.696	2.3	Re-186	3.777	0.2
Cr-51	27.704	0.16	Re-188	0.708	0.26
Cu-64	0.529	1.2	Sc-47	3.351	0.56
Cu-67	2.578	0.58	Se-75	119.8	2.6
Ga-67	3.261	0.753	Sm-153	1.946	0.425
I-123	0.55	1.61	Sn-117m	13.61	1.48
I-125	60.14	1.42	Sr-89	50.5	NA [†]
I-125 implant	60.14	1.11 [‡]	Tc-99m	0.251	0.756
I-131	8.04	2.2	Tl-201	3.044	0.447
In-111	2.83	3.21	Y-90	2.67	NA [†]
Ir-192 implant	74.02	4.59 [‡]	Yb-169	32.01	1.83
P-32	14.29	NA [†]			

* References for half-lives and exposure rate constants are shown in Table A-2.

** A. Meigooni, S. Sabnis, and R. Nath, "Dosimetry of Palladium-103 Brachytherapy Sources for Permanent Implants," *Endocurietherapy Hyperthermia Oncology*, Volume 6, April 1990. The exposure rate constant given is an "apparent" value (i.e., with respect to an apparent source activity) and takes into account the attenuation of gamma rays within the implant capsule itself.

‡ R. Nath, A.S. Meigooni, and J.A. Meli, "Dosimetry on Transverse Axes of ¹²⁵I and ¹⁹²Ir Interstitial Brachytherapy Sources," *Medical Physics*, Volume 17, Number 6, November/December 1990. The exposure rate constant given is a measured value averaged for several source models and takes into account the attenuation of gamma rays within the implant capsule itself.

† Not applicable (NA) because the release activity is not based on beta emissions.

NOTE: Although non-byproduct materials are not regulated by the NRC, information on non-byproduct material is included in this regulatory analysis for the convenience of the licensee.

Table A.2 Exposure Rate Constants, Release Activities, and Release Dose Rates †

Isotope	Half-Life ** (days)	Intensity † (fraction/disintegration)	Energy † (MeV)	Linear Energy-Absorption Coefficient †† (1/m)	MeV/cm/disintegration	Exposure Rate		Release Activity Based On 0.5 rem to Total Decay			Release Dose Rate at 1 Meter for Q ₀ (mrem/hr)
						R/Ci-hr at 1 Meter	R/mCi-hr at 1 cm	Q ₀ (mCi)	Q ₀ (MBq)	Q ₀ (GBq)	
Ag-111	7.45	0.000245	0.022984	4.30E-02	2.42E-09	3.63E-05	3.63E-04	(Occupancy Factor = 0.25)			
		0.000462	0.023174	4.00E-02	4.28E-09	6.42E-05	6.42E-04				
		0.000151	0.0261	2.80E-02	1.10E-09	1.65E-05	1.65E-04				
		0.001202	0.09675	3.00E-03	3.49E-09	5.23E-05	5.23E-04				
		0.012291	0.24539	3.60E-03	1.09E-07	1.63E-03	1.63E-02				
		0.0668	0.34213	3.80E-03	8.68E-07	1.30E-02	1.30E-01				
		0.000559	0.65472	3.80E-03	1.39E-08	2.09E-04	2.09E-03				
Exposure Rate Constant (Total)*						1.50E-02	1.50E-01	5.17E+02	1.91E+04	1.91E+01	7.76E+00
Au-198	2.696							(Occupancy Factor = 0.25)			
Exposure Rate Constant**						2.30E-01	2.30E+00	9.32E+01	3.45E+03	3.45E+00	2.14E+01
Cr-51	27.704							(Occupancy Factor = 0.25)			
Exposure Rate Constant**						1.60E-02	1.60E-01	1.30E+02	4.82E+03	4.82E+00	2.09E+00
Cu-64	0.529							(Occupancy Factor = 1.0)			
Exposure Rate Constant**						1.20E-01	1.20E+00	2.28E+02	8.42E+03	8.42E+00	2.73E+01
Cu-67	2.578							(Occupancy Factor = 0.25)			
Exposure Rate Constant***						5.80E-02	5.80E-01	3.87E+02	1.43E+04	1.43E+01	2.24E+01
Ga-67	3.261	0.02856	0.091266	3.00E-03	7.82E-08	1.17E-03	1.17E-02	(Occupancy Factor = 0.25)			
		0.357	0.093311	2.95E-03	9.83E-07	1.47E-02	1.47E-01				
		0.19706	0.18458	3.40E-03	1.24E-06	1.85E-02	1.85E-01				
		0.02242	0.20895	3.50E-03	1.64E-07	2.46E-03	2.46E-02				
		0.15994	0.30022	3.75E-03	1.80E-06	2.70E-02	2.70E-01				
		0.044768	0.39353	3.90E-03	6.87E-07	1.03E-02	1.03E-01				
		0.001385	0.88769	3.65E-03	4.49E-08	6.73E-04	6.73E-03				
0.001247	0.62941	3.85E-03	3.02E-08	4.53E-04	4.53E-03						
Exposure Rate Constant (Total)*						7.53E-02	7.53E-01	2.35E+02	8.71E+03	8.71E+00	1.77E+01