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Date: August 17, 1983

To: Holders of NUREG-0172

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Subject: Changes and Corrections for NUREG-0172

Equation A-2, Page A-1, and Equation A-3, Page A-2, are incorrect. They yielded correct answers in NUREG-0172 only because T_1 was 365 days in those calculations. The correct equations are:

$$K_{i1j} = 18.7 * F_w/365 * T_1 * (\lambda_e^o)^2 \qquad \text{A-2}$$

$$K_{i2j} = 18.7 * F_a/365 * T_1 * (\lambda_e^o)^2 \qquad \text{A-3}$$

Equation A-11, Page A-5, is missing a negative sign inside of the last parenthesis at the last exponent. It should be:

$$P_{4ipj} = \ldots \text{EXP}\ (- T_A * \lambda_e^o)] \qquad \text{A-11}$$

The equation for internal organ doses from inhalation of "insoluble" particulates will reduce to zero over zero if the effective half-life in the organ is numerically equivalent to the effective half-life in the lung. This happens occasionally but the particular computer used to perform the dose factor calculations did not give an error signal. Instead, it printed some value (at random??).

The situation can arise in either of 2 ways: 1) if the biological half-life of the radionuclide in the organ is exactly 120 days (1 year for Pu or 4 years for Th), or 2) if the radiological half-life is very short compared to the biological half-life.

The simplest solution is to define the effective half-life in the lung and organ as being different. A difference of one part in 10,000 seems to be sufficient for our computer to yield essentially the same answer as the more precise solution which follows.

The second solution was to rederive the equation starting with the assumption that the effective half-life in the lung and the organ are identical. The new equation is given below for the case of inhalation by an adult. The step-wise derivation for other ages has not yet been compiled from the adult equation. It may not be necessary in view of the first and simpler solution.

$$DF = K \left\{ 2(1+e^{-\lambda^o t_2} - e^{-\lambda^o t_1} - e^{-\lambda^o \Delta t}) + \lambda^o (t_1 + t_2 e^{-\lambda^o t_2} - \Delta t\, e^{-\lambda^o \Delta t}) \right\}$$

$$\text{where } K = \frac{6.40 \text{ E-3 } \lambda_B^L \, (f_2' \, \varepsilon/m)^o}{(\lambda^o)^3} \text{ mrem per pCi/day}$$

$$\text{or } K = \frac{1.75 \text{ E-5 } \lambda_B^L \, (f_2' \, \varepsilon/m)^o}{(\lambda^o)^3} \text{ mrem per pCi/yr}$$

t_1 = period of inhalation (days)

t_2 = period over which dose is calculated (days)

$\Delta t = t_2 - t_1$ (days)

^{o} = effective half-life in organ (days) (also = effective half-life in lung, ^{L}).

Using this equation, the dose factor for inhaled Be-10 in the kidney (biological half-life = 120 d) is calculated to be 4.24E-5. The value given in NUREG-0172 is 8.98E-8. For Zn-69, the same answer was obtained from this equation as from the equation given in NUREG-0172 with a difference of one part in 10,000 in the two effective half-lives.

B. Upgrading of Metabolic Parameters

1) Newer values for F-W and T-BIOL for Sr nuclides where given in ICRP Publications 10, and 10A and were utilized by ORNL in their INREM code. These new values were used to recalculate the pertinent dose factors. The only nuclide with significant changes in effective half-life (and dose factors) was Sr-90. The newer parameter values are:

T-BIOL = 4000 days (all Sr nuclides)
F-W = 0.051 (Sr-90 only)
F-A = 0.17 (Sr-90 only)
F-* = 0.95 (Sr-90 only) GI-LLI INGES only

The change in F_W changes F* GI-LLI INGESTION from 0.7 to 0.95. Only the bone, total-body, and GI-LLI ingestion dose factors for Sr-90 will change as a result of the above changes.

2) The new energy for ^3H is 0.0057 MeV/dis for all ages and for all organs (except bone).

3) The metabolic model for transuranic nuclides from ICRP-19 should be used in place of that given in ICRP Publication 2 actually used in NUREG-0172. This leads to several important changes for Np, Pu, Am, Cm and Cf. These are:

T-BIOL in bone should be changed to 100 years (for all TRU)
T-BIOL in liver should be changed to 40 years (for all TRU)
F-2 PRM in bone should be changed to 0.45 (for all TRU)
F-2 PRM in liver should be changed to 0.45 (for all TRU)
F-2 PRM in other organs remains unchanged (for all TRU).

C. Punch Card Errors

Table I lists errors found in the input data listed in Appendix B and the changes discussed above. There may still be a few undetected errors. The effect on the calculated dose factors has been addressed in the footnotes to Table I. Certain changes are linearly related to the end product if they are uniform for all ages such as F-2 PRM. The changes for the Sr-90 dose factors are given in Table II. Those for the TRU nuclides have not yet been formulated.

Also included on the table are recalculated values of epsilon for Th-229. Since both the old an new values of epsilon are independent of age, the new dose factors will be directly proportional to the change in epsilon.

TABLE I. Changes in Parameter Values in Appendix B NUREG-0172

Page	Nuclide	Line	Column	Old Value	New Value
B-6	H-3(a)	Total Body	Epsilon for all ages	1.0E-2	5.7E-3
B-9	Sc-46(b)	GI-INHAL	F-A	0.62	0.50
B-16	Sr-89(c)	Bone	T-BIOL	1.8E4	4000
		Total Body	T-BIOL	1.3E4	4000
		Bone	T-EFF	50.36	49.89
		Total Body	T-EFF	50.30	49.89
B-17	Sr-90(d)	Bone	T-BIOL	1.8E4	4000
		Total Body	T-BIOL	1.3E4	4000
		Bone	T-EFF	6605	2903
		Total Body	T-EFF	5834	2903
		Bone	F-W	0.0225	0.051
		Total Body	F-W	0.30	0.051
		Bone	F-A	0.30	0.17
		Total Body	F-A	1.0	0.17
		GI-INGES	F-*	0.7	0.95
	Sr-91(c)	Bone	T-BIOL	1.8E4	4000
		Total Body	T-BIOL	1.3E4	4000
	Sr-92(c)	Bone	T-BIOL	1.8E4	4000
		Total Body	T-BIOL	1.3E4	4000
B-19	Zr-93+D(e)	All organs except bone	Epsilon for Infant, Child, Teen	Divided old values by 10	
B-28	Te-133M+D(f)	GI-INGES	Epsilon for adult	11.62	1.62
		GI-INHAL		11.62	1.62
B-40	Ho-166M(g)	GI-INGES	f* GI	0.0	1.00
			Epsilon for all ages	0.0	0.20
B-41	Pb-210+D(h)	GI-INGES	Epsilon for all ages	0.46	0.019
		GI-INHAL		0.46	0.019

TABLE I. (continued)

Page	Nuclide	Line	Column	Old Value	New Value
B-41	Bi-210+D	Total Body(i)	F-W	1.5E-3	1.0E-2
		Bone(j)	F-A	0.0	0.03
B-44	Th-229(k)	Bone	Epsilon for all ages	940	1600
		Liver		49	160
		Total Body		330	190
		Thyroid		49	160
		Kidney		49	160
		Lung INGES		270	280
		Lung INHAL		270	280
		GI-INGES		4.0	0.61
		GI-INHAL		4.0	0.61
B-44	Th-232+D(l)	Total Body	T-BIOL	5.7E+6	5.7E+4
			T-EFF	5.7E+6	5.7E+4

(a) New dose factors for all organs and all ages for inhalation and ingestion will be (0.57) times the dose factors (DFs), now listed in NUREG-0172.

(b) New DFs for GI-LLI, inhalation, for Sc-46 for all ages will be (0.50/0.60) times the old factors.

(c) No changes in DFs for Sr-89, Sr-91, or Sr-92 will result from these changes.

(d) The new values for Sr-90 for bone and total body are listed in Table II. The new DFs for GI INGEST will be (0.95/0.70) times the old DFs for all ages.

(e) New DFs for Zr-93+D for inhalation and ingestion for infant, child and teen, for all organs except bone, will be (0.10) times the old DFs. No adult DFs will change.

(f) Adult DFs for Te-133+D for GI-LL for both inhalation and ingestion will be (1.62/11.62) times the old DFs.

(g) New DFs for Ho-166M for GI-LLI, ingestion, will be (1.0/0.62) times those now listed for GI-LLI inhalation.

(h) New DFs for Pb-210+D for GI-LLI for both ingestion and inhalation for all ages will be (0.019/0.46) times those currently listed.

(i) New DFs for Bi-210+D for total body for all ages will be (1.0E-2/1.5E-3) times those now listed.

(j) The recalculated DFs for Bi-210+D for bone, inhalation just happen to be (0.50) times those listed now for bone, ingestion.

(k) The new DFs for all ages, organs, and inhalation and ingestion will be directly proportional to the change in Epsilon. For example, the DF for bone will all be (1600/940) times the old DFs for bone for all ages and for both inhalation and ingestion.

(l) New DFs for Th-232+D for total body for all ages and for both ingestion and inhalation will be (0.01) times those now listed.

TABLE II. Change in Sr-90 Dose Factors for Bone and Total Body

	Bone		Total Body	
Intake/Age	Old Value	New Value	Old Value	New Value
Ingestion				
Infant	1.85E-2	2.83E-2	4.71E-3	5.74E-4
Child	1.70E-2	2.56E-2	4.31E-3	5.15E-4
Teen	8.30E-3	1.02E-2	2.05E-3	2.04E-4
Adult	7.58E-3	8.71E-3	1.86E-3	1.75E-4
Inhalation				
Infant	2.92E-2	1.11E-2	1.85E-3	2.23E-4
Child	2.73E-2	1.04E-2	1.74E-3	2.07E-4
Teen	1.35E-2	4.14E-3	8.35E-4	8.33E-5
Adult	1.24E-2	3.59E-3	7.62E-4	7.21E-5