

Development and Application of a Code for Internal Exposure (CINEX) based on the CINDY code

T. Kravchik, N. Duchan, R. Sarah, Y. Gabay, R. Kol*

Nuclear Research Centre Negev, P.O.B. 9001, Beer-Sheva, 84190, Israel

Internal exposure to radioactive materials at the NRCN is evaluated using the CINDY (Code for Internal Dosimetry) Package. The code was developed by the Pacific Northwest Laboratory to assist the interpretation of bioassay data, provide bioassay projections and evaluate committed and calendar-year doses from intake or bioassay measurement data. It provides capabilities to calculate organ dose and effective dose equivalents using the International Commission on Radiological Protection (ICRP) 30 approach.

The CINDY code operates under DOS operating system and consequently its operation needs a relatively long procedure which also includes a lot of manual typing that can lead to personal human mistakes.

A new code has been developed at the NRCN, the CINEX (Code for Internal Exposure), which is an Excel application and leads to a significant reduction in calculation time (in the order of 5-10 times) and in the risk of personal human mistakes. The code uses a database containing tables which were constructed by the CINDY and contain the bioassay values predicted by the ICRP30 model after an intake of an activity unit of each isotope. Using the database, the code then calculates the appropriate intake and consequently the committed effective dose and organ dose.

Calculations with the CINEX code were compared to similar calculations with the CINDY code. The discrepancies were less than 5%, which is the rounding error of the CINDY code. Attached is a table which compares parameters calculated with the CINEX and the CINDY codes (for a class Y uranium). The CINEX is now used at the NRCN to calculate occupational intakes and doses to workers with radioactive materials.

*deceased

Table 1 – A comparison between parameters calculated with the CINEX and the CINDY codes for class Y uranium

discrepancy (%)	calculated with CINEX	calculated with CINDY		(ICRP-30)	Class Y	Uranium
					1 um	AMAD
					5.00	Intake (mg)
0.00%	4.00E+02	4.00E+02	Committed effective dose			
2.94%	3.30E+03	3.40E+03	Committed dose to lungs			

discrepancy between CINDY and CINEX (%)	daily urinary excretion CINEX (mg/d)	daily urinary excretion CINDY (mg/d)	discrepancy between CINDY and CINEX (%)	retention in lungs CINEX (mg)	retention in lungs CINDY (mg)	time after intake (Days)
0.00%	9.50E-03	9.50E-03	-4.17%	1.25E+00	1.20E+00	0.50
1.19%	4.15E-03	4.20E-03	4.55%	1.05E+00	1.10E+00	1.00
2.75%	5.84E-04	6.00E-04	1.32%	7.50E-01	7.60E-01	5.33
1.61%	3.05E-04	3.10E-04	-1.35%	7.50E-01	7.40E-01	15.00
3.13%	1.55E-04	1.60E-04	-2.74%	7.50E-01	7.30E-01	30.00
0.00%	1.00E-04	1.00E-04	2.78%	7.00E-01	7.20E-01	45.46
2.44%	8.00E-05	8.20E-05	1.41%	7.00E-01	7.10E-01	59.00
-1.12%	9.00E-05	8.90E-05	3.23%	6.00E-01	6.20E-01	179.29
0.00%	9.00E-05	9.00E-05	0.00%	6.00E-01	6.00E-01	218.00
-2.15%	9.50E-05	9.30E-05	3.85%	5.00E-01	5.20E-01	364.00
1.16%	8.50E-05	8.60E-05	-1.39%	3.65E-01	3.60E-01	732.00
1.41%	7.00E-05	7.10E-05	0.00%	2.30E-01	2.30E-01	1250.67
-3.77%	5.50E-05	5.30E-05	3.33%	1.45E-01	1.50E-01	1824.00
1.14%	4.35E-05	4.40E-05	0.00%	1.10E-01	1.10E-01	2191.00
0.00%	1.80E-05	1.80E-05	-0.74%	4.84E-02	4.80E-02	3649.33
1.41%	7.00E-06	7.10E-06	0.00%	2.90E-02	2.90E-02	5113.00
0.35%	1.89E-06	1.90E-06	0.00%	2.10E-02	2.10E-02	7294.00
0.00%	4.00E-07	4.00E-07	0.00%	1.90E-02	1.90E-02	10588.67
-0.51%	2.51E-07	2.50E-07	0.00%	1.90E-02	1.90E-02	12113.00
-0.02%	1.60E-07	1.60E-07	0.00%	1.90E-02	1.90E-02	14234.00
-4.29%	1.56E-07	1.50E-07	0.00%	1.90E-02	1.90E-02	14365.00
-0.36%	1.10E-07	1.10E-07	0.00%	1.90E-02	1.90E-02	16396.00
-1.19%	8.50E-08	8.40E-08	0.00%	1.90E-02	1.90E-02	18250.00