# Estimates of Effective Doses among Czech Uranium Miners

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Czech uranium mining started on industrial base in the 1890s. It is estimated that total production has been 110 000 t of uranium and the uranium industry employed nearly 100 000 underground workers. Radiation doses in uranium mines include contribution form inhalation of uranium dust (long lived radionuclides), inhalation of radon and from external gamma radiation.

Mine dosimetrist and research team at the Rozna Mine

The presentation is aimed at the estimation of radiation doses from long lived radionuclides, which is based on measurements of physical and chemical characteristics conducted recently in the Czech uranium mines. The main studied parameters were: size,
chemical solubility in lung fluid,
and amount of Rn gas emanating from uranium particles.

The mean size of particles for different radionuclides in terms of AMAD was in the range 5.2-7.8 μm. Study of kinetics of dissolution of uranium collected on filters from personal dosimeters ALGADE resulted in estimated rapidly dissolved fraction of 0.142 and 0.177 for U-238 and U-234, respectively. Fraction of Rn gas escaping from uranium particles was estimated by measuring the ratio of activities of radon progeny and Ra-226. These fractions, which determine how the gross long lived alpha activity is divided into separate radionuclides of the uranium series, were in the range 23% - 56% with the mean of 43%.

Based on these parameters, committed effective doses from long lived radionuclides in uranium dust were calculated using IMBAsoftware. Doses form radon and external gamma radiation are given for comparison.

## Effective doses (mSv) from unit intake (kBq) of long lived radionuclides

| AMAD | <0.4 μm | 5 μm | 10 μm | 7 μm | 5 μm [a] | 10 μm [a] | 7 μm [a] |
|---|---|---|---|---|---|---|---|
| U-238 | 5.84 | 3.09 | 1.87 | 2.50 | 3.72 | 2.75 | 3.25 |
| U-234 | 6.79 | 3.98 | 2.41 | 3.23 | 4.64 | 3.38 | 4.04 |
| Th-230 | 8.78 | 4.96 | 3.06 | 4.04 | 5.83 | 4.34 | 5.09 |
| Ra-226 | 10.6 | 6.18 | 3.92 | 5.09 | 7.18 | 5.38 | 6.31 |
| Po-210 | 5.15 | 3.32 | 1.80 | 2.60 | 3.78 | 2.56 | 3.20 |
| Pb-210 | 0.76 | 1.10 | 0.94 | 1.02 | 1.03 | 0.90 | 0.97 |
| U-235 | 6.19 | 3.41 | 2.07 | 2.76 | 4.05 | 2.98 | 3.53 |
| Pa-231 | 10.3 | 5.82 | 3.56 | 4.73 | 6.84 | 5.03 | 5.96 |
| Ac-227 | 36.2 | 24.5 | 15.0 | 19.9 | 27.1 | 19.5 | 23.5 |
| weighted sum [b] | 38.09 | 22.46 | 13.88 | 18.33 | 26.07 | 19.20 | 22.76 |
| resulting conversion | 5.8 | 3.4 | 2.1 | 2.8 | 3.9 | 2.9 | 3.4 |

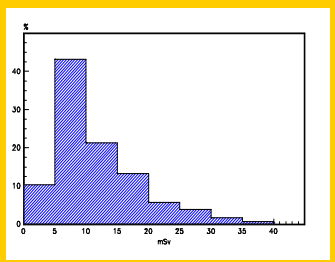
[a] Correction for 20% fraction of fine particles (<0.4 μm)
[b] Assuming fraction $^{235}U/^{238}U$= 0.0526 and 43% Rn escape, ie. n=6.61 alpha emitters

Correlations of effective doses
(adjusted for duration of exposure)

| | LL alpha | Rn | gamma |
|---|---|---|---|
| LL alpha | 1.00 | 0.39 | 0.57 |
| Rn | 0.39 | 1.00 | 0.46 |
| gamma | 0.57 | 0.46 | 1.00 |

Distribution of effective doses
in underground workers

| effective dose mSv | LL alpha | Rn | gamma |
|---|---|---|---|
| 0-5 | 79.2% | 79.2% | 70.2% |
| 5-10 | 15.9% | 19.3% | 24.2% |
| 10-15 | 4.1% | 1.5% | 4.4% |
| 15-20 | 0.5% | | 0.8% |
| 20-25 | 0.1% | | 0.2% |
| 25+ | | | 0.1% |
| mean | 3.2 | 3.5 | 4.6 |




Distribution of total annual effective doses
(adjusted for annual duration of 1700 hours)

AM = 113 mSv
SD = 6.6 mSv

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