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The role of natural ventilation in the exposure to radon in the Postojna Cave

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Postojna Cave is the biggest of 21 show caves in Slovenia and one of present day's most visited show caves in the world. Long and branched out cave system, large entrances at different levels, inflow of the Pivka river, and large variation of the outdoor air temperature and precipitation, make the Postojna Cave also a very complex climatic system in which each part shows different conditions. The cave is only naturally ventilated and it is therefore characterised by high radon concentration, which depends on the ventilation regime in different seasons, resulting in typical annual cycles of radon levels in the cave air. Postojna Cave is a typical horizontal cave, where the difference between outside and cave air temperature represents the main driving force for air circulation. In winter, when the cave temperature is higher than outside, cave air is released from the cave into the outdoor atmosphere due to the air draught caused by the 'chimney effect', thus allowing fresh and cold outdoor air to enter the cave through low lying openings. This effect is not operative in summer, when the outside temperature is higher than in the cave, and air draught is minimal or reversed. In addition, air circulation can be locally altered due to other processes, like changing level of Pivka river during the rainy season and local geomorphologic characteristics of cave passages.

High radon concentration in the Postojna Cave is the reason for thorough studies of the methodology for dose estimates of the personnel working in the cave. Due to high relative humidity and low air circulation, the cave air is characterised by very low particle concentration, which play an important role in radon dosimetry. Therefore parallel monitoring of radioactive aerosols of radon decay products (RnDP) and general (non-radioactive) aerosols in the particle size range of 10–1100 nm was performed in the air of Postojna Cave at the lowest point of tourist path in summer, winter and both transitional periods (spring and autumn), focusing on the unattached fraction of RnDP (f^{un}), a key parameter in radon dosimetry. Dose conversion factors (*DCF*) were calculated (using Porstendörfer approach) from measured f^{un} for the four periods and compared with recommended *DCF*, based on the results of epidemiological studies.

Results of calculated *DCF* are in the range from 8–18 mSV WLM^{-1}, much higher that recommended values, and differ significantly for summer and winter period. The lowest value of *DCF* was calculated for winter period, when the enhanced inflow of cold outside air introduces outdoor aerosols into the cave and consequently lowers f^{un}. On the other hand, calculated *DCF* during summer period was significantly higher, caused by high f^{un}, which is the consequence of very low particle concentration in cave air during summer ventilation regime. Taking into account also significantly higher radon concentration during summer, when about 70 % of visits is recorded, it is evident, that personnel receives the highest annual dose during summer months.